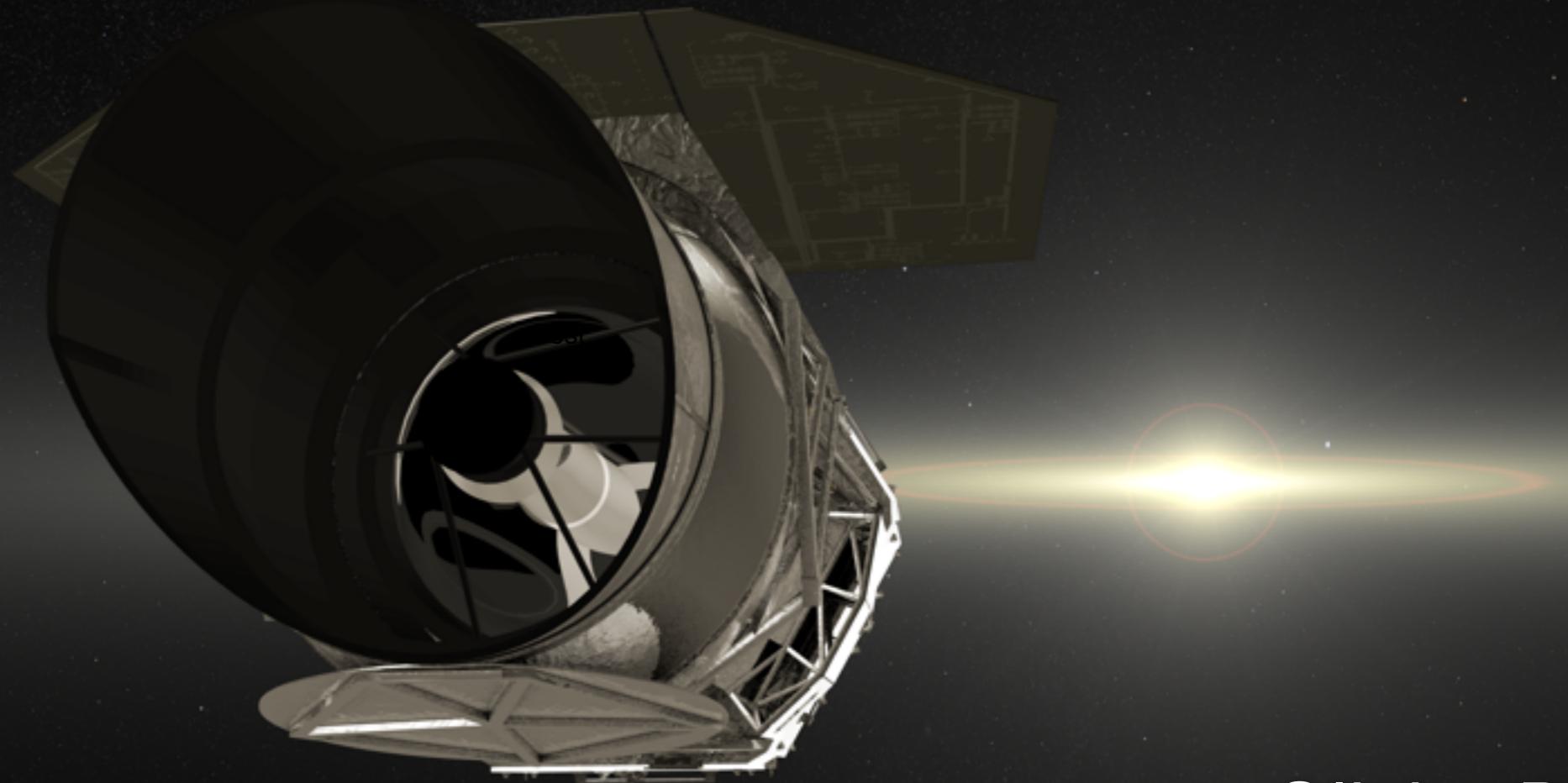


WFIRST

STATUS AND PROSPECTS

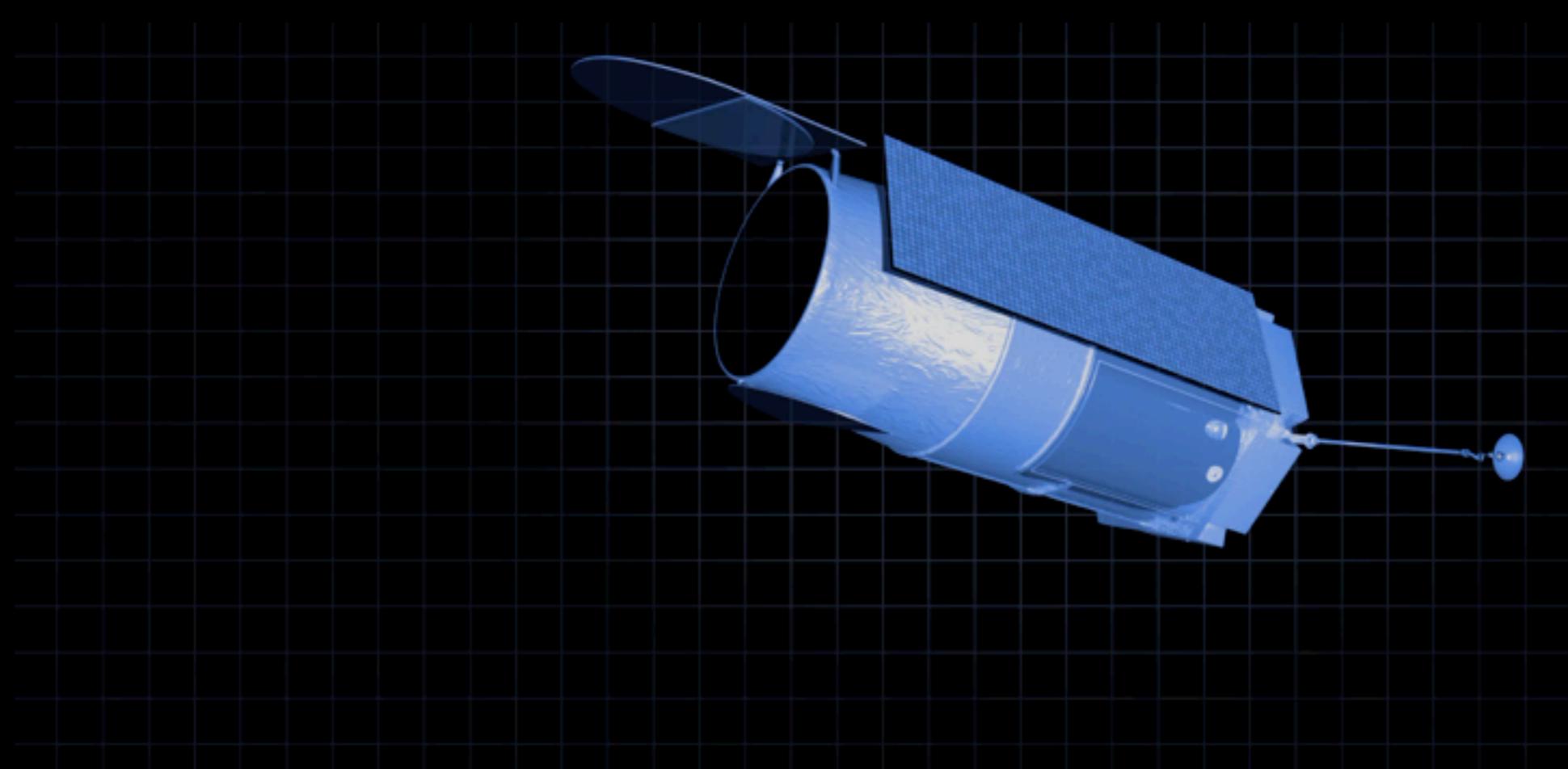


Olivier Doré
Jet Propulsion Laboratory/California Institute of Technology

“Cosmology with the WFIRST High Latitude Survey” Science Investigation Team
www.wfirst-hls-cosmology.org
www.wfirst.gsfc.nasa.gov

WFIRST, THE NEXT NASA FLASHSHIP

- Top priority from the 2010 Astrophysics Decadal Survey
- Hubble sized telescope, donated by the National Reconnaissance Office
- Hubble power and resolution, 100x the field of view
 - ➡ Hubble quality image over 100x more sky
- Dark energy, exoplanet, and wide-field survey capabilities
- Coronagraph technology to build the “Search for Life” foundation





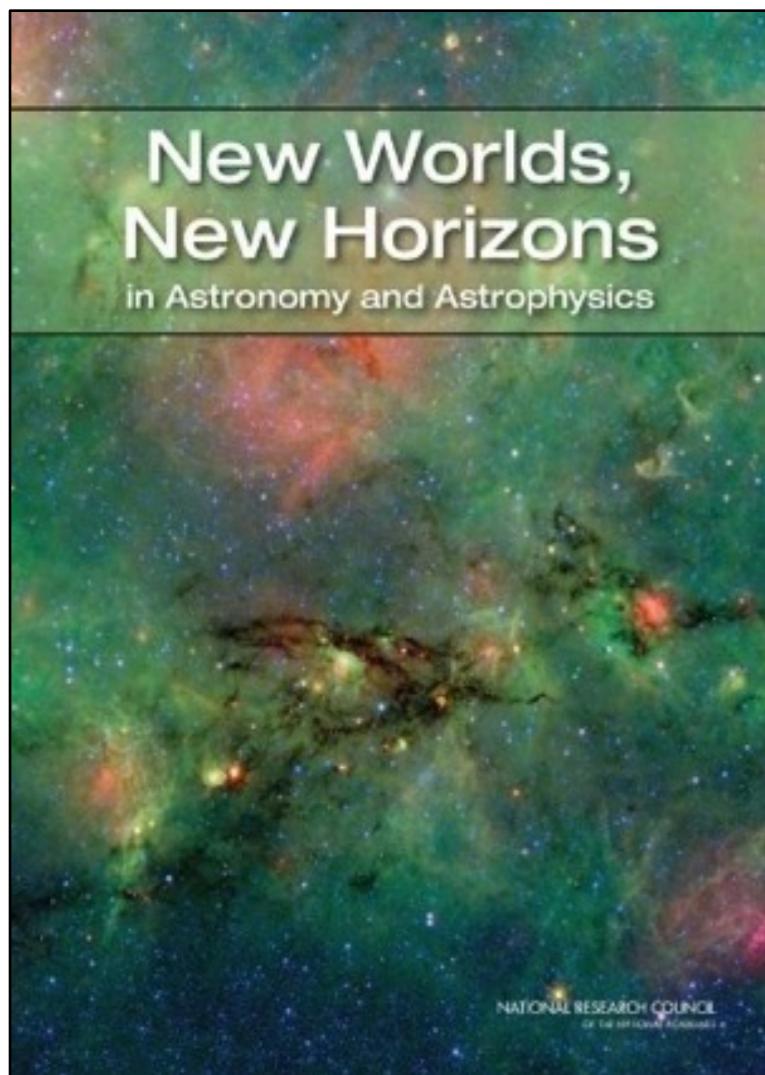
WFIRST Checks Many Boxes

Highest Priority

#1 Large-Scale Priority - Dark Energy, Exoplanets

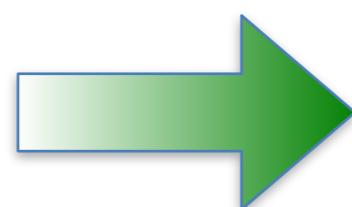
#1 Medium-Scale Priority - New Worlds Tech. Development
(prepare for 2020s planet imaging mission)

WFIRST covers many other NWNH science goals



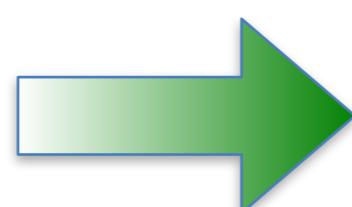
5 Discovery Science Areas

- ID & Characterize Nearby Habitable Exoplanets ✓
- Time-Domain Astronomy ✓
- Astrometry ✓
- Epoch of Reionization ✓
- Gravitational Wave Astrometry

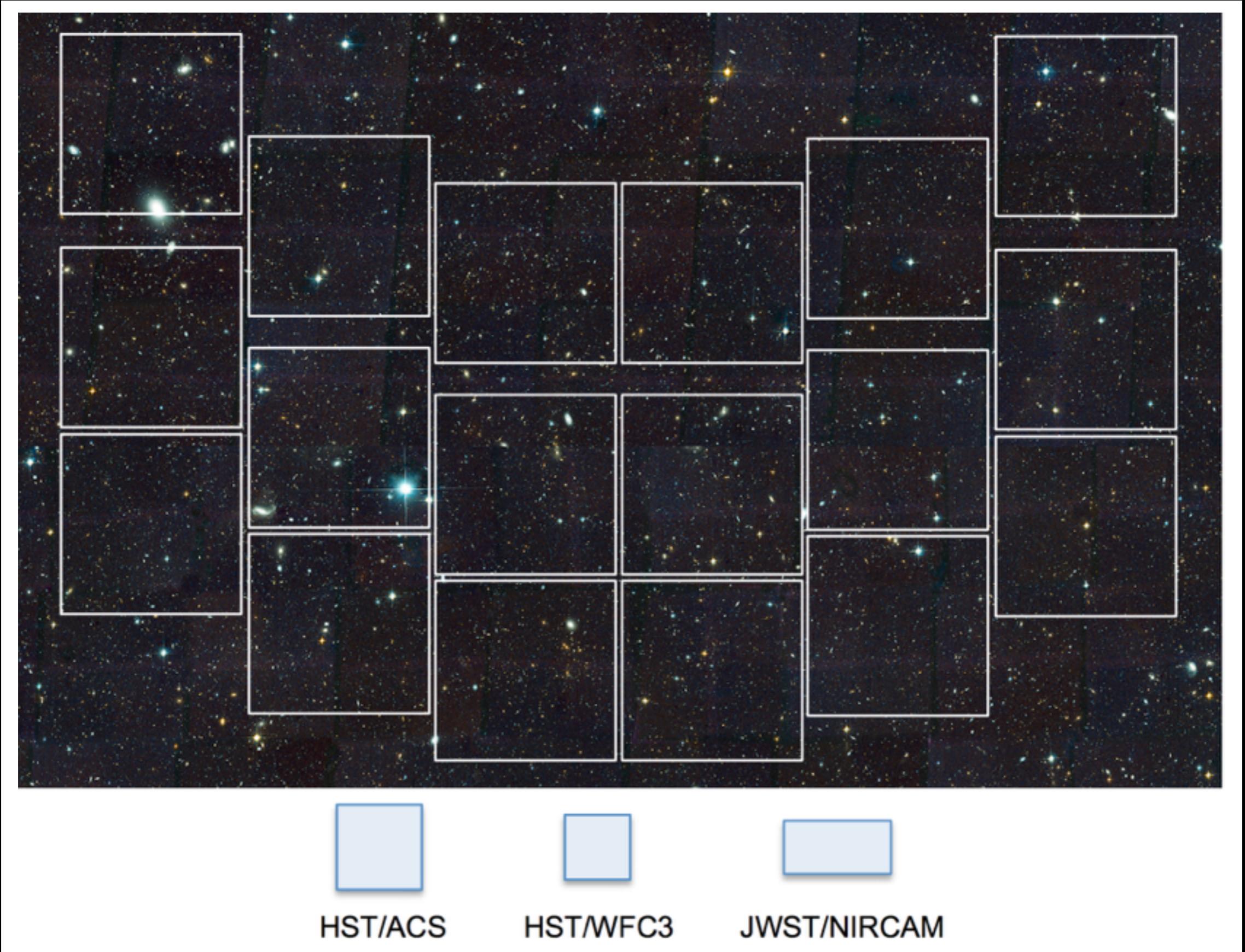


20 Key Science Questions

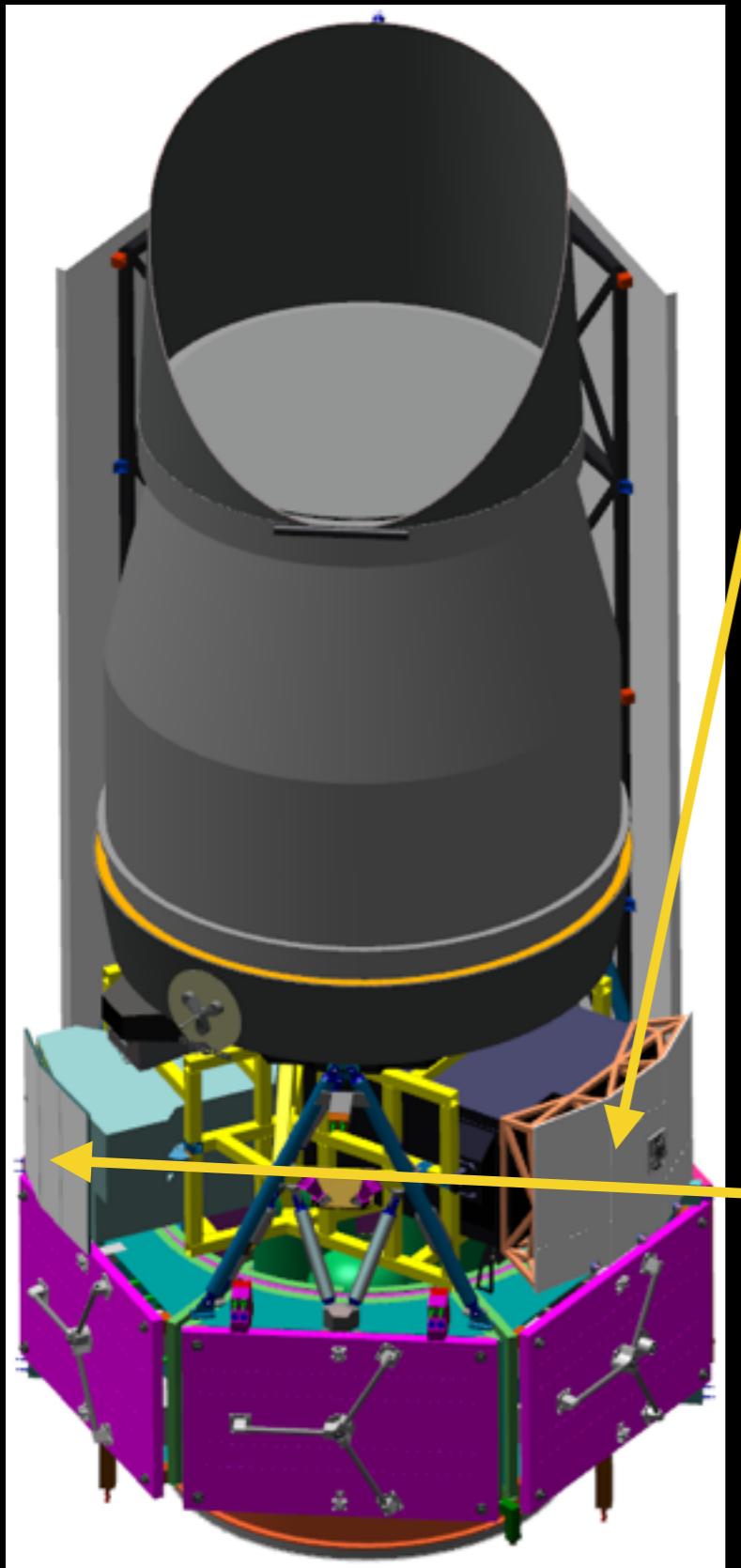
- Origins (7/7 key areas)
- Understanding the Cosmic Order (6/10 key areas)
- Frontiers of Knowledge (3/4 key areas)



A 0.28 SQ. DEG. FIELD OF VIEW



WFIRST INSTRUMENT

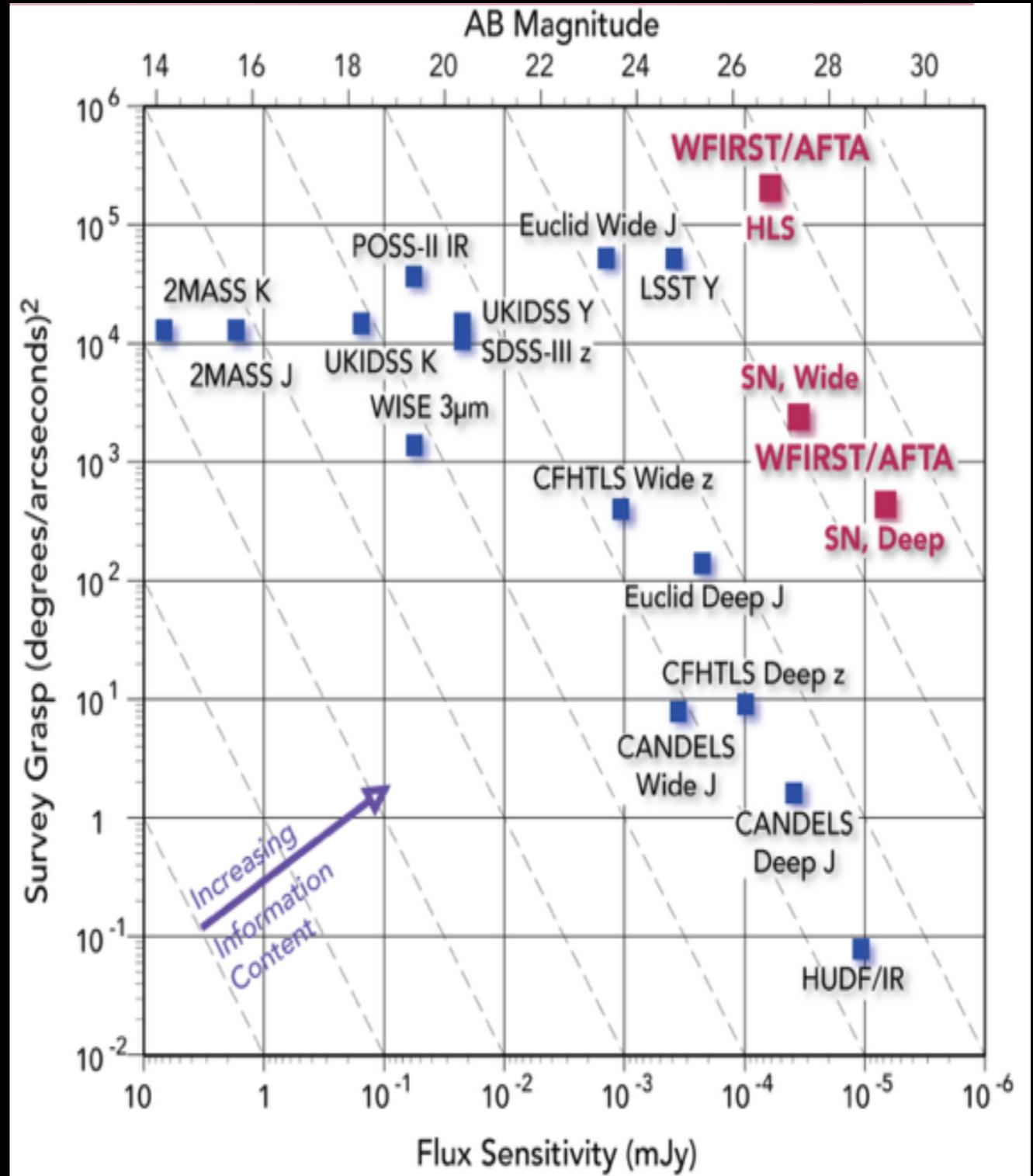


- Wide-Field Instrument
 - ▶ Imaging & spectroscopy over 1000s of sq. deg.
 - ▶ Monitoring of SN and microlensing fields
 - ▶ 0.7-2.0 mm (imaging), 1.35-1.89 mm (spec.)
 - ▶ 0.28 deg² FoV (100x JWST FoV)
 - ▶ 18 H4RG detectors (288 Mpixels)
 - ▶ 6 filter imaging, grism + IFC spectroscopy

- Coronagraph
 - ▶ Image and spectra of exoplanets from super-Earths to giants
 - ▶ Images of debris disks
 - ▶ 430 – 970 nm (imaging) & 600 – 970 nm (IFS spec.)
 - ▶ Final contrast of 10^{-9} or better
 - ▶ Exoplanet images from 0.1 to 1.0 arcsec

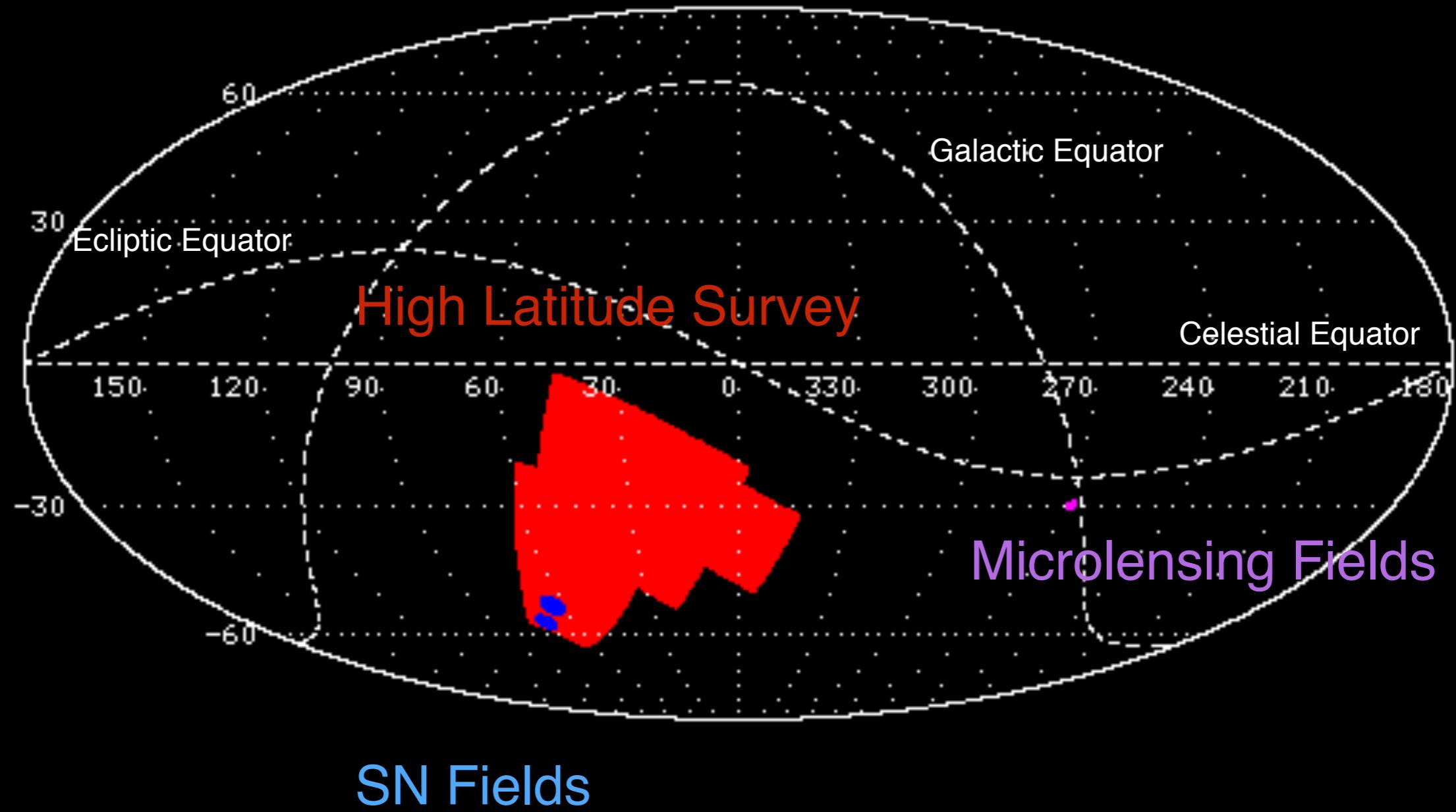
WFIRST SURVEYS

- Nominal 6 yrs mission
- 2 yrs High-Latitude Survey (HLS)
 - ➡ Imaging, spectroscopy
- ~6 months SNe search and IFC follow-up
- ~1 yr for coronograph
- ~1 yr for repeated galactic bulge observations for microlensing
- 25% Guest Observer program
- All data public after days after they are taken



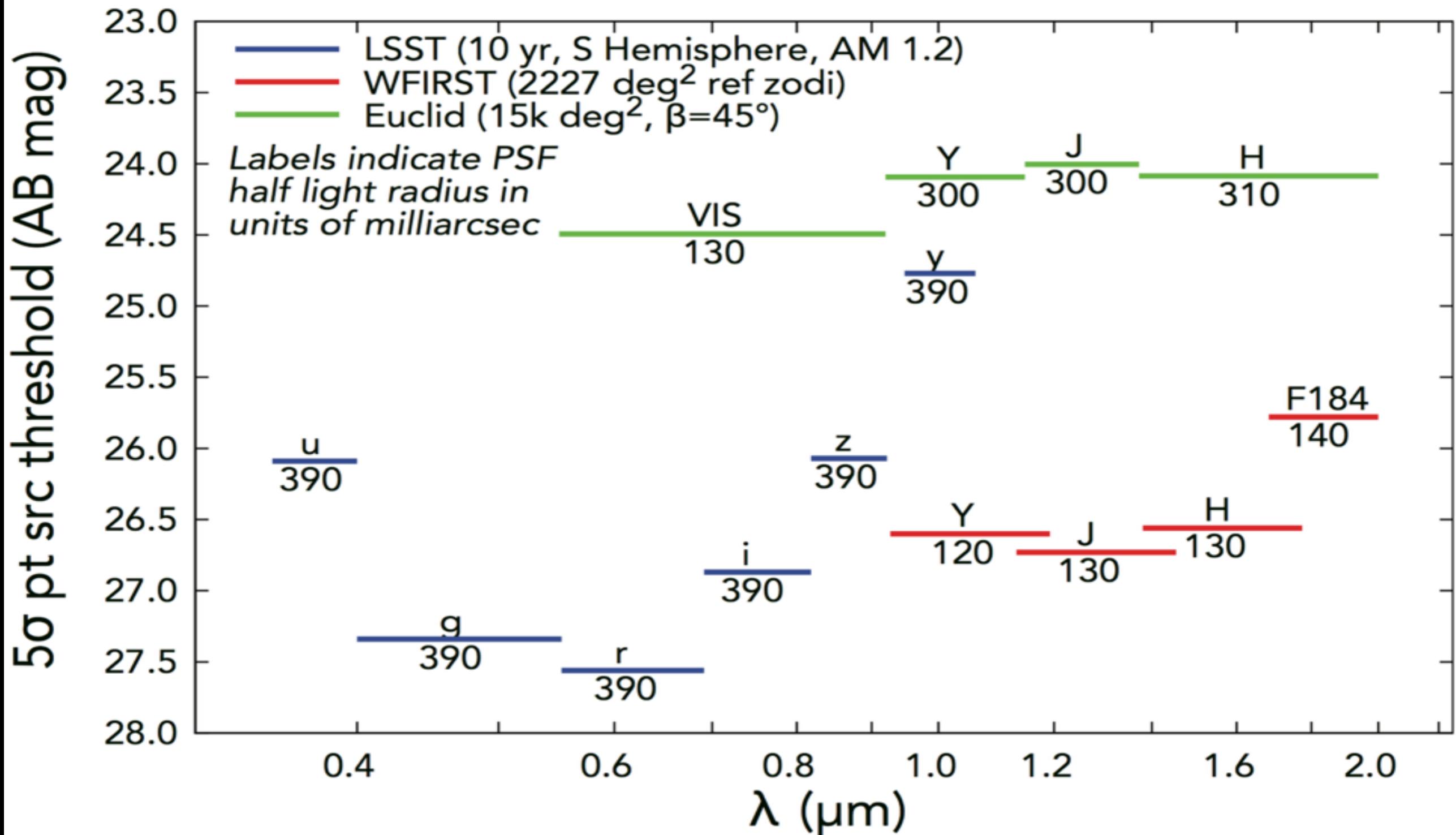
SKY COVERAGE

WFIRST Observation Map: Nobs=564188
Equatorial Coordinates



WFIRST HLS SENSITIVITY

Sensitivities of LSST, WFIRST, and Euclid



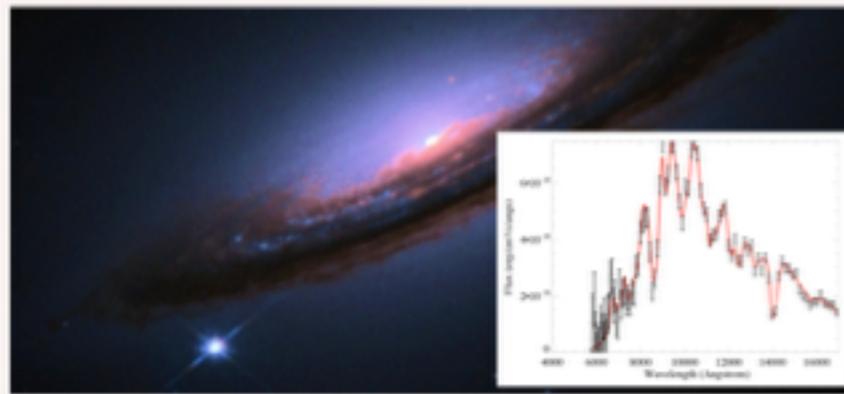
WFIRST DARK ENERGY PROGRAM

Supernova Survey

wide, medium, & deep imaging
+
IFU spectroscopy

2700 type Ia supernovae
 $z = 0.1\text{--}1.7$

standard candle distances
 $z < 1$ to 0.20% and $z > 1$ to 0.34%



High Latitude Survey

spectroscopic: galaxy redshifts

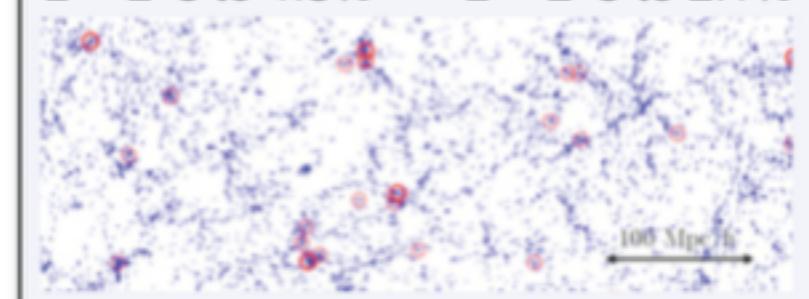
16 million H α galaxies, $z = 1\text{--}2$
1.4 million [OIII] galaxies, $z = 2\text{--}3$

imaging: weak lensing shapes

380 million lensed galaxies
40,000 massive clusters



standard ruler
distances expansion rate
 $z = 1\text{--}2$ to 0.5% $z = 1\text{--}2$ to 0.9%
 $z = 2\text{--}3$ to 1.3% $z = 2\text{--}3$ to 2.1%



dark matter clustering
 $z < 1$ to 0.21% (WL); 0.24% (CL)
 $z > 1$ to 0.78% (WL); 0.88% (CL)
1.1% (RSD)

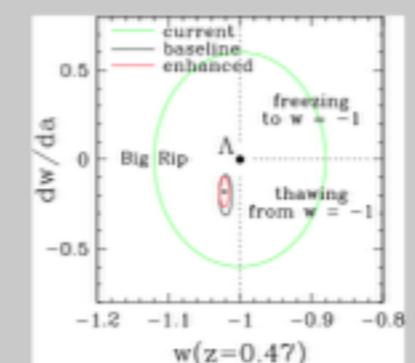


history of dark energy

+

deviations from GR

$w(z)$, $\Delta G(z)$, $\Phi_{\text{REL}}/\Phi_{\text{NREL}}$



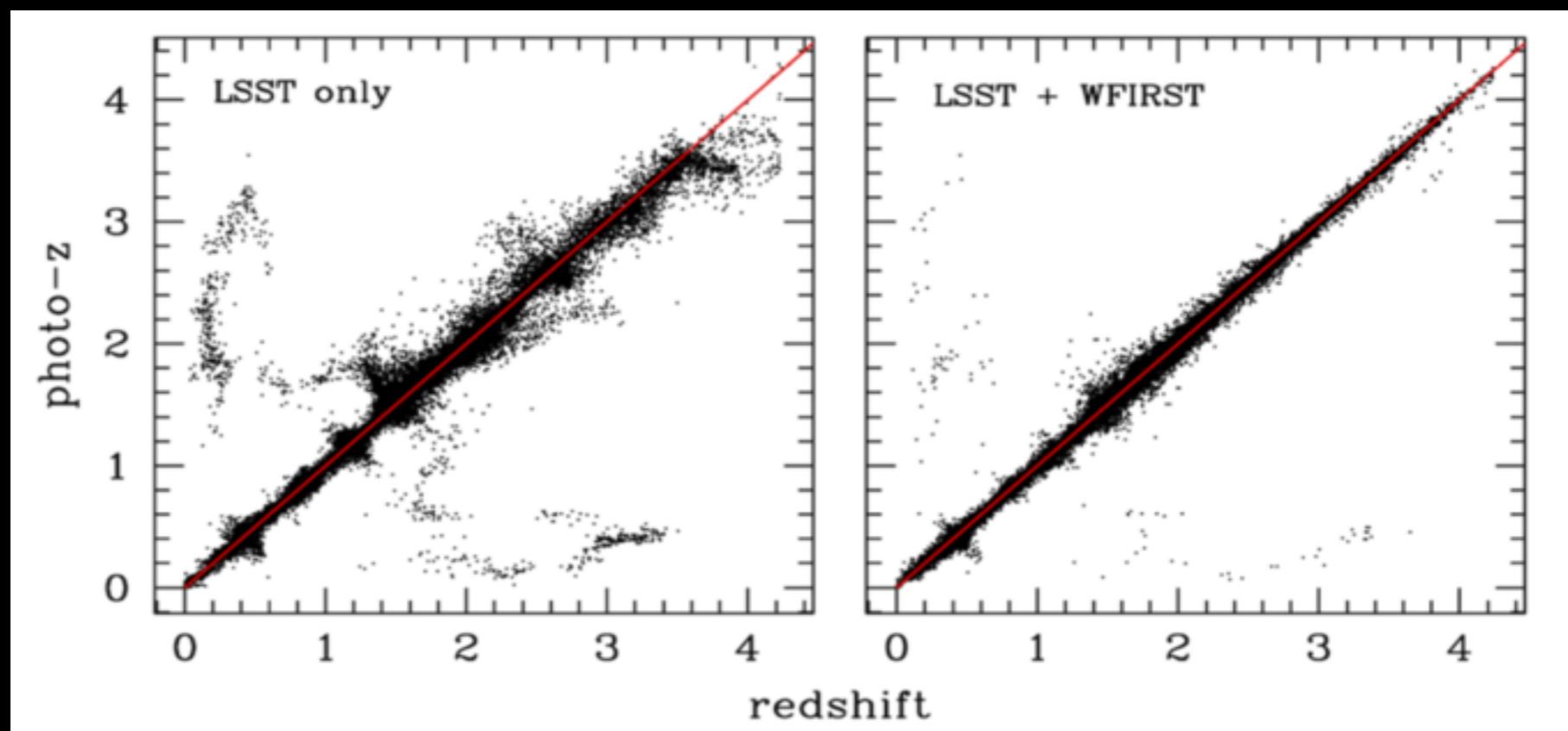
SURVEY COMPLEMENTARITY AT A GLANCE

Stage IV	LSST	WFIRST	Euclid	DESI
Starts, duration	2020, 10yr	~2025, 5-6 yr	2020 Q2, 6.25yr	~2018, 5 yr
Area (deg ²)	20,000 (S)	2,400 (S)	15,000 (N + S)	14,000 (N)
FoV (deg ²)	10	0.281	0.53	7.9
Diameter (m)	6.7	2.4	1.3	4 (less 1.8+)
Imaging galaxies (per sq arcmin)	~30 over 6 bands (ugrizy)	68, in 6 bands into near IR	~30-35, in one broad optical + IR band	
SN1a	$10^4\text{-}10^5$ SN1a/yr z = 0.–0.7 photometric	2700 SN1a z = 0.1–1.7 IFU spectroscopy		
Spectroscopic Survey		Grism R=550-800 1.35-1.95 mm	Grism R=250 1.1-2 mm	Fibers R=3-4000) 360-980 nm
Sample		ELGs: z = 1-2 (20m), 2–3 (2m)	ELGs: z~0.7-2.1 (~20m)	LRGs+ELGs z~0.6-1.7 (20-30m), QSOs/Lya 1.9<z<4 (1m)

Slide from R. Bean

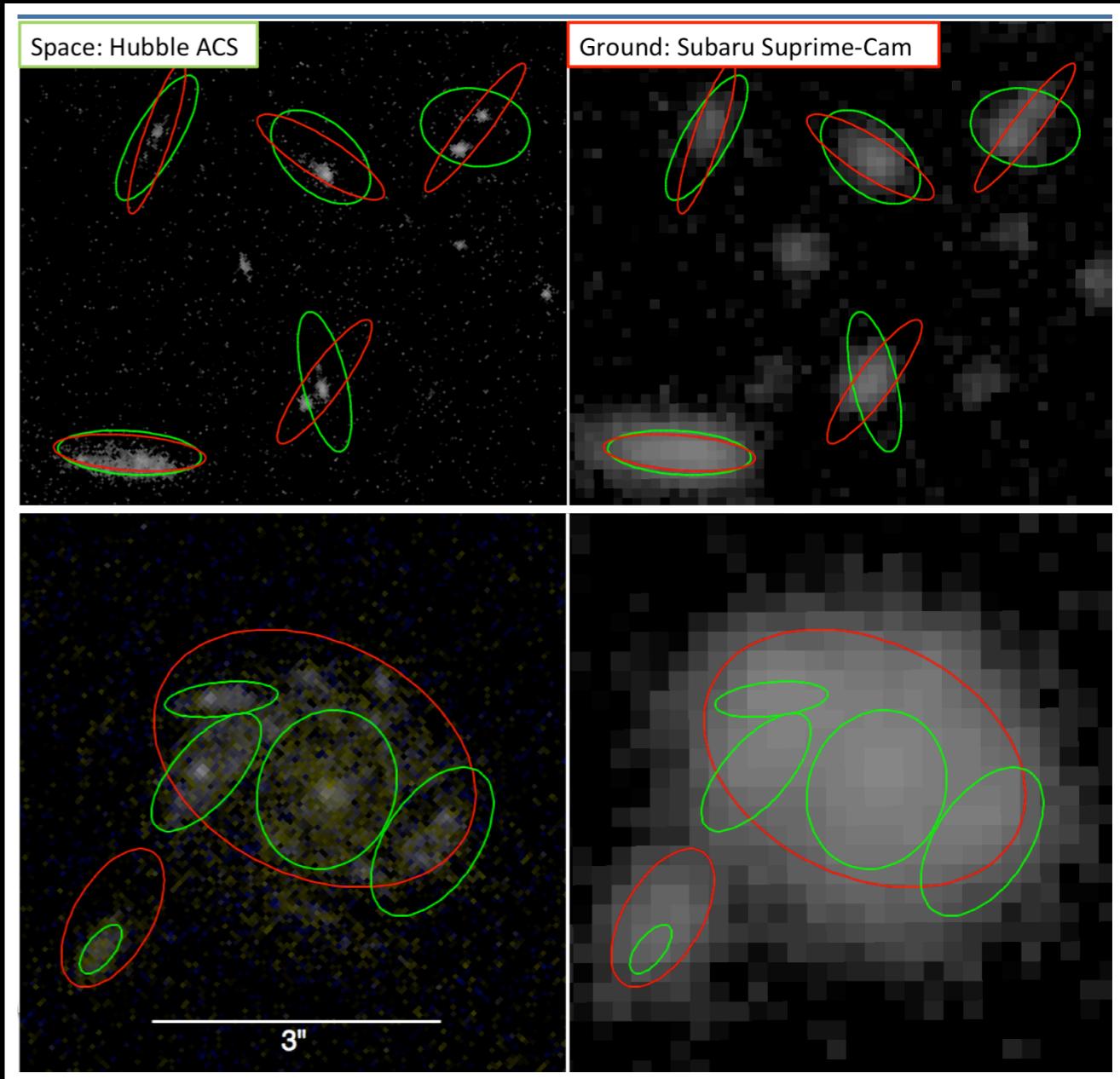
SYNERGIES AT THE PIXEL LEVEL WITH LSST

- WFIRST photo-z's limited by distinguishing features in galaxy SEDs at WFIRST wavelengths, i.e., not limited by photometric precision or spectroscopic training samples.
- Combination with LSST 6 optical bands is sufficient for shear, assuming a reliable cross-matching of catalogs/sources can be made.
- But catalog based analysis will not be enough...



THE BLENDING PROBLEM IN LSST

- Catalog cross-matching is confused by significant object blending as seen by LSST.
- Blending problem is serious for LSST ($\sim 10\%$ of the lensing sources), leads to bias in shear estimation and photometric redshifts.
- Situation is worse in galaxy clusters and will lead to multiple bias if uncorrected.
- Joint pixel level analysis are needed.



Melchior, Schneider

SYNERGIES WITH WFIRST FIRST OBSERVATIONS

- Start the SNe deep survey (~ 5 sq. deg., J=29.3, H=29.4)
- Overlap with LSST deep drilling fields
- Overlap HSC deep fields
- Spitzer data? (P. Capak)
- eROSITA data?
- Other wavelengths?
- Targets for JWST/ELTs
- Important field:
 - ➡ Training for high latitude survey
 - ➡ Characterize Wide Field Instrument performance
 - ➡ Where to look?

WFIRST STATUS

- WFIRST moving forward – Phase A entered in 2016
- Detector, coronagraph development
 - ➡ On track for TRL-6 in 2017
- 2025 (2024?) Launch for a 6 year primary mission
- Reviews:
 - ➡ ASM July 2016
 - ➡ SRR/MDR July 2017
 - ➡ KDP-B October 2017
- Science meetings:
 - ➡ WFIRST-LSST meeting September 13-15, 2016
 - ➡ WFIRST conference June 26-30, 2017
 - Astronomy in the 2020s: Synergies with WFIRST @ STScI
 - ➡ WFIRST and other Survey Synergies, Fall 2017, Caltech (more soon)

WFIRST Formulation Science Working Group (FSWG)

- Serves as WFIRST's science executive committee:
 - 24 members
 - Project Scientists and Instrument Scientists from GSFC and JPL
 - STScI and IPAC are preparing for a joint WFIRST Science Centers

- 2 Adjutant Scientists:

→ David Spergel	Wide Field Instrument
→ Jeremy Kasdin	Coronograph Instrument

- 10 Science Investigation Teams:

→ Olivier Doré	Weak lensing and galaxy redshift survey
→ Saul Perlmutter	Supernovae
→ Ryan Foley	Supernovae
→ Scott Gaudi	Microlensing
→ Bruce Macintosh	Coronagraphy
→ Margaret Turnbull	Coronagraphy
→ James Rhoads	GO science, cosmic dawn
→ Brant Robertson	GO science, galaxy formation & evolution
→ Benjamin Williams	GO science, nearby galaxies
→ Alexander Szalay	GI science, archival research



FIN

www.wfirst-hls-cosmology.org
www.wfirst.gsfc.nasa.gov